

CLAIMS

1. A method for checking a weld between a first metal pipeline and a second metal pipeline, in particular an austenitic weld, characterized in that the method comprises at least the following method steps:
 - a. a first ultrasonic beam is transmitted to an interface between the weld and the first pipeline situated on a first side of the weld;
 - 5 b. a reflection of the first ultrasonic beam on the interface situated on the first side of the weld is received and a first received signal corresponding thereto is generated;
 - c. a second ultrasonic beam different from the first ultrasonic beam is transmitted to the interface situated on the first side of the weld;
 - 10 d. a reflection of the second ultrasonic beam on the interface situated on the first side of the weld is received and a second received signal corresponding thereto is generated;
 - e. the first received signal and the second received signal are processed in combination for checking the weld.
2. A method according to claim 1, characterized in that the first and the second ultrasonic beam at the interface between the weld and the first pipeline have a mutually different angle of incidence on the interface.
3. A method according to any one of the preceding claims,
20 characterized in that in step a. the first ultrasonic beam is directed such that the direction in which the first ultrasonic beam is incident on the interface between the weld and the first pipeline deviates from the normal to a surface of the interface between the weld and the first pipeline at the point where the first ultrasonic beam is incident on the interface.
- 25 4. A method according to any one of the preceding claims, characterized in that in step a. the first ultrasonic beam is supplied to the interface between the weld and the first pipeline via the first pipeline.

5. A method according to claim 4, characterized in that in step a. the first ultrasonic beam is supplied to the first pipeline and propagates via the first pipeline to the weld.
6. A method according to any one of the preceding claims,
5 characterized in that in step a. the first ultrasonic beam is supplied to the first pipeline from an outer side of the first pipeline.
7. A method according to any one of the preceding claims 1-5,
characterized in that in step a. the first ultrasonic beam is supplied from an inner side of the first or second pipeline.
- 10 8. A method according to any one of the preceding claims,
characterized in that in step a., for the first ultrasonic beam a longitudinal wave is used.
9. A method according to any one of the preceding claims,
characterized in that in step a. the first ultrasonic beam is focused.
- 15 10. A method according to any one of the preceding claims,
characterized in that in step a. the transmitted first ultrasonic beam is a pulsed wave.
11. A method according to any one of the preceding claims,
characterized in that in step b. the reflection of the first ultrasonic beam is
20 measured that comes from a direction that deviates from the direction in which the first ultrasonic beam would reflect on the interface according to the rule that the angle of incidence is equal to the angle of reflection, so that the first ultrasonic received signal represents a defraction, if any, of the first ultrasonic beam on the interface between the weld and the first pipeline.
- 25 12. A method according to any one of the preceding claims,
characterized in that in step b. the reflection of the first ultrasonic beam is measured that comes from a direction which, at least substantially, coincides with the direction in which the first ultrasonic beam is incident on the interface between the first pipeline and the weld.

13. A method according to any one of the preceding claims, characterized in that the reflection of the first ultrasonic beam is received on an outer side of the first pipeline.
14. A method according to claim 12 or 13, characterized in that the 5 first ultrasonic beam is transmitted and received with one and the same probe.
15. A method according to any one of the preceding claims, characterized in that in step c. the second ultrasonic beam is directed such that the direction in which the second ultrasonic beam is incident on the 10 interface between the weld and the first pipeline at least substantially does not deviate from the normal to a surface of the interface between the weld and the first pipeline at the point where the second ultrasonic beam is incident on the interface.
16. A method according to any one of the preceding claims, 15 characterized in that in step c. the second ultrasonic beam is supplied to the interface between the weld and the first pipeline via the second pipeline and the weld.
17. A method according to any one of the preceding claims, characterized in that in step c. the second ultrasonic beam, after being 20 transmitted, first of all propagates through the second pipeline to an interface between the second pipeline and a second side of the weld situated opposite the first side of the weld, after which the second ultrasonic beam proceeds to propagate through the weld to the interface between the weld and the first pipeline.
- 25 18. A method according to any one of the preceding claims, characterized in that in step c. the second ultrasonic beam is supplied to the second pipeline from an outer side of the second pipeline.
19. A method according to any one of the preceding claims 1-17, characterized in that in step c. the second ultrasonic beam is supplied to the 30 weld from an inner side of the first or second pipeline.

20. A method according to any one of the preceding claims, characterized in that in step c., for the second ultrasonic beam a longitudinal wave is used.
21. A method according to any one of the preceding claims, 5 characterized in that in step c. the second ultrasonic beam is focused.
22. A method according to any one of the preceding claims, characterized in that the second ultrasonic beam is a pulsed wave.
23. A method according to any one of the preceding claims, characterized in that in step d. a reflection of the second ultrasonic beam is 10 measured coming from a direction which, at least substantially, coincides with the direction in which the second ultrasonic beam would reflect on a surface of the interface at the point where the second beam is incident on the interface.
24. A method according to any one of the preceding claims, 15 characterized in that the reflection of the second ultrasonic beam is received on an outer side of the second pipeline.
25. A method according to claim 23 or 24, characterized in that the second ultrasonic beam is transmitted and received with one and the same probe.
- 20 26. A method according to any one of the preceding claims, characterized in that in step e., on the basis of the first and second received signals, it is determined whether the weld comprises a defect.
27. A method according to claim 26, characterized in that that in 25 step e. it is determined on the basis of the first received signal whether the weld may comprise a defect and it is determined on the basis of the second received signal whether the weld may comprise a defect, it being concluded that the weld actually comprises a defect when both on the basis of the first received signal and on the basis of the second received signal it is concluded that the weld may comprise a defect.

28. A method according to claim 27, characterized in that in step e. the amplitude of the first received signal is compared with a first reference to determine whether the weld may comprise a defect and the amplitude of the second received signal is compared with a second reference to determine 5 whether the weld may comprise a defect.

29. A method according to any one of the preceding claims, characterized in that the method furthermore comprises at least the following method steps:

10 f. a third ultrasonic beam is transmitted to the interface between the weld and the first pipeline situated on the first side of the weld;

15 g. a reflection of the third ultrasonic beam on the interface situated on the first side of the weld, according to the rule that the angle of incidence is equal to the angle of reflection on the surface of the interface between the weld and the first pipeline is received and a third received signal corresponding thereto is generated; and

h. the third received signal is analyzed for checking the weld.

30. A method according to claim 29, characterized in that the third beam is directed such that the direction in which the third beam is incident on the interface between the weld and the first pipeline generally deviates from the 20 normal to a surface of the interface between the weld and the first pipeline at the point where the third beam is incident on the interface between the weld and the first pipeline.

31. A method according to claim 29 or 30, characterized in that in step f. the third ultrasonic beam is supplied to the interface between the weld and 25 the first pipeline via the first pipeline.

32. A method according to claim 29, 30 or 31, characterized in that in step f. the third ultrasonic beam is supplied to the first pipeline and propagates via the first pipeline to the weld.

33. A method according to any one of the preceding claims 29-32, characterized in that in step f. the third ultrasonic beam is supplied to the first pipeline from an outer side of the first pipeline.
34. A method according to any one of the preceding claims 29-33, 5 characterized in that in step f. the third ultrasonic beam is supplied from an inner side of the first or second pipeline.
35. A method according to any one of the preceding claims 29-34, characterized in that in step f., for the third ultrasonic beam a transverse wave is used.
- 10 36. A method according to any one of the preceding claims 29-35, characterized in that in step f. the third ultrasonic beam is focused.
37. A method according to any one of the preceding claims 29-36, characterized in that in step f. the transmitted third ultrasonic beam is a pulsed wave.
- 15 38. A method according to any one of the preceding claims 29-37, characterized in that in step g. the reflection of the third ultrasonic beam is measured that comes from a direction which, at least substantially, coincides with the direction in which the third ultrasonic beam would reflect on the interface according to the rule that the angle of incidence is equal to 20 the angle of reflection, so that the third ultrasonic received signal represents a reflection, if any, of the third ultrasonic beam on a possible flaw at the interface between the weld and the first pipeline.
39. A method according to claim 38, characterized in that the third ultrasonic beam, after being reflected on the interface between the weld and 25 the first pipeline, propagates to an inner wall of the first pipeline and reflects on the inner wall of the first pipeline to be subsequently received.
40. A method according to any one of the preceding claims 29-39, characterized in that the third ultrasonic beam is generally received with a different probe than the one it is transmitted with.

41. A method according to any one of the preceding claims 29-40, characterized in that in step g. on the basis of an amplitude of the third received signal, the magnitude of a defect, if any, is determined.

42. A method according to claim 41, characterized in that the magnitude of the defect, if any, is determined by comparing the amplitude with a reference.

43. A method according to any one of claims 29-42, characterized in that on the basis of the third received signal the magnitude of the defect is determined if on the basis of the performance of the method step e. it appears that the weld comprises a defect.

44. A method according to any one of the preceding claims, characterized in that in a step i. a reflection of the second ultrasonic beam on the interface situated on the first side of the weld is received according to the rule that the angle of incidence is equal to the angle of reflection on the surface of the interface between the weld and the first pipeline is received and a fifth received signal corresponding thereto is generated.

45. A method according to claim 44, characterized in that in a step j. on the basis of an amplitude of the fifth received signal obtained in step h., the magnitude of a defect, if any, is determined.

46. A method according to any one of the preceding claims, characterized in that in step b. also a reflection of the first ultrasonic beam on an interface of the weld between the weld and the second pipeline is measured to obtain the first received signal and that a fourth ultrasonic beam is supplied to the interface of the weld between the weld and the second pipeline to obtain a fourth received signal, while the first and the fourth ultrasonic beams at the interface between the weld and the second pipeline have a mutually different angle of incidence on the interface between the weld and the second pipeline, and the first received signal and the fourth received signal are processed in combination for checking the interface between the weld

and the second pipeline, in particular to determine whether the interface between the weld and the second pipeline comprises a defect.

47. A method according to any one of the preceding claims, characterized in that an interface between the weld and the second pipeline is checked as 5 the interface between the first pipeline and the weld is checked, while the first ultrasonic beam is also used for checking the interface between the second pipeline and the weld in a same way as the second ultrasonic beam is used for checking the interface between the weld and the first pipeline.

48. A method according to any one of the preceding claims, characterized 10 in that an interface between the weld and the second pipeline is checked as the interface between the first pipeline and the weld is checked, while the second ultrasonic beam is also used for checking the interface between the second pipeline and the weld in a same way as the first ultrasonic beam is used for checking the interface between the weld and the first pipeline.

15 49. A method according to any one of the preceding claims, characterized in that the first ultrasonic beam and the second ultrasonic beam are incident at least substantially on a same area of the interface between the first pipeline and the weld in order for this area of the interface to be checked.

20 50. A method according to any one of claims 29-43 and according to claim 49, characterized in that the third ultrasonic beam is incident at least substantially on the same said area.

51. A method according to any one of the preceding claims, characterized 25 in that the first ultrasonic beam and the second ultrasonic beam are directed to a same area of the interface between the first pipeline and the weld.

52. A method according to any one of claims 29-43 and according to claim 51, characterized in that the third ultrasonic beam is directed to said area of the interface between the first pipeline and the weld.